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UNIT REQUIREMENTS FOR PRODUCING MARKET MILK IN VERMONT.

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CHARACTER AND SCOPE OF THE WORK.

To determine the requirements of milk production and to obtain data which would aid in improving milk-production methods, the United States Department of Agriculture, through the Dairy Division, Bureau of Animal Industry, began a series of studies in 1915. These studies were made in detail on practical dairy farms in various market milk centers of the United States, and the project with which this bulletin deals was undertaken in a market milk section of Vermont.

The work of this project, which was located in Addison County, was begun on all but three of the herds in November and December, 1916, and on these three in March, 1917. Although the records of the last three herds were not completed until March, 1919, they are included and reported with the records of the herds completed in December, 1918.

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The project was located in this section because most of the milk produced was market milk. The milk from the farms was hauled to central receiving stations for shipment to New York City, and the equipment and methods used in the production and handling of the milk were subject to the supervision of sanitary inspectors from the city, who visited the dairies regularly. The figures reported show the relation of the various factors used in producing milk in the section studied and probably approximate the requirements of similar sections, but they do not apply to dairying in sections where other conditions and management prevail. The herds and farms represented typical conditions in the section studied, and the cooperation of members of cow-testing associations was obtained.

The quantities of feed and labor are expressed in pounds and hours instead of money cost, so that current prices may be applied.

METHODS USED IN OBTAINING THE DATA.

The figures are actual records obtained by regular monthly 24-hour visits to 17 farms during the first year [1] and 18 farms during the second year. The record work was continued for the second year on 11 of the 17 farms visited the first year.

The field agents of the department recorded in detail all available information relative to the dairy business, including the amounts and classes of labor, feeds, bedding, pasture cost, amount of milk sold and used on the farm, and current expenses for the month. Accurate data on calves and first-hand information on methods of handling manure were systematically collected.

By obtaining records [2] on every dairy regularly each month the influence of unusual circumstances at the time of any particular visit was lessened, and by using the records of all the herds for each month complete data for each month, season, and year were obtained. Data were obtained for two entire years in order to compare one year with the other in the same section and to increase the amount of data for study.

At the beginning and end of each year the field agent took an inventory of the dairy buildings, livestock, and equipment used in the care of the herd and its products. On his regular monthly inspection tour he arrived at the first farm of a group in time to observe the first labor operations connected with the evening chores. With watch in hand he noted and recorded the minute each labor operation connected with the dairy was begun and ended. The labor operations during the next day were recorded in the same manner.

[1] Howard B. Cannon carried on the field work during the first 6 months, until it was taken over by Ralph P. Hotis.

[2] Copies of the blanks and description of the methods used can be obtained on application to the Dairy Division, Bureau of Animal Industry.

The field agent also verified the records of feeds that were being fed on the inspection day, recording the kind, quantity, cost, and description of each, and compared them with the quantities recorded by the cow tester in the cow-testing-association books.

The quantity of milk sold and receipts each month were obtained, and the whole milk used by the proprietor and his help or fed to calves which were being raised was measured or weighed and used as a basis for determining the amount kept on the farm during the month.

Each dairyman kept an itemized account of expenses which were incurred between the monthly visits, and these items were recorded by the field agent. A monthly record was also kept of the purchase or sale of cows, calves, and hides. Outside bull service and other miscellaneous information relating to the herd were recorded. The field agent also noted the condition and methods of handling the manure and reported it each month.

When all the labor operations about the dairy had been completed for the day at the first farm, the field agent drove to the next farm in time to observe the labor operations connected with the evening chores. This program was followed each day until Saturday afternoon, when he returned to his official headquarters and finished his reports for the week's work. The same program was followed each week, so that each farm under observation was visited for a working day every 30 days throughout the two years.

WINTER AND SUMMER FEEDING.

Since the winter and summer seasons have a marked influence on the principal factors entering into the cost of producing milk, the results have been computed separately for those periods. The months from November to April, inclusive, represent the winter season, and from May to October the summer season.

The various tables found in this bulletin are based upon figures obtained during the two years of the study, and the weighted average of the two-year records was used whenever it would more accurately express the result. The weighted average was obtained by giving each item a different weight in the average according to its relative importance.

DESCRIPTION OF THE HERDS.

The principal dairy breeds were well represented by grade and purebred animals, but the Holsteins were most numerous. During the first year records were obtained on 17 herds having an average size of 26.1 cows, with an average annual production, per cow, of 5,415 pounds of milk, testing 4.0 per cent butterfat. Eighteen herds were studied during the second year. These herds had an average

of 22.4 cows, with an average annual production of 5,111 pounds of 3.9 per cent milk per cow.

Out of each 100 cows during the two years, 58 freshened during the winter six months and 27 during the summer six months, while 15 cows did not drop calves during the year. Thus there were 85 calves each year for every 100 cows in the herds. During the first winter the cows were dry 2.7 months (average) before dropping calves and 2.2 months during the second winter. In the first summer the cows were dry for 2.5 months before calving and 2.7 months during the second summer. The difference between the number of cows freshening in the winter and in the summer indicates that the cows were not bred to freshen uniformly throughout the year. The larger number of calves born during the winter does not mean that winter dairying was practiced to so great an extent as the number of cows freshening at that time would seem to indicate, for most of these cows freshened in the latter part of the winter and were really "summer cows."

REQUIREMENTS FOR PRODUCING 100 POUNDS OF MILK.

As the price of milk is generally based on 100-pound quantities, the requirements for milk production were based on this unit. The results are given in Table 1 and the credit for calves and manure in Table 2.

TABLE 1.—*Unit requirements, except charge for management, for producing 100 pounds of milk in winter and in summer.*

Item.	Winter.		Average of two winters.	Summer.		Average of two summers.
	1916–17	1917–18		1917	1918	
Feed:						
Purchased concentrates.....pounds..	29.0	30.2	29.6	7.2	9.2	8.1
Home-grown grains.....do....	3.2	3.8	3.5	.5	.6	.6
Total concentrates.....do....	32.2	34.0	33.1	7.7	9.8	8.7
Noncommercial roughage.....do....	1.1	1.2	1.2	3.4	.5	2.1
Commercial roughage:						
Carbohydrate hay.....do....	108.7	121.4	114.7	10.4	18.2	13.9
Legume hay.....do....	18.2	9.4	14.0	2.9	2.6	2.7
Total dry roughage.....do....	128.0	132.0	129.9	16.7	21.3	18.7
Silage and other succulent roughage .....pounds..	193.2	189.2	191.3	19.9	37.4	27.8
Pasture.....acres..	.....	.....	.....	.09	.11	.10
Bedding.....pounds..	10.0	12.5	11.2	.....	.....	.....
Hauling and grinding concentrates .....dollars..	.....	.....	0.020	.....	.....	0.005
Labor:						
Human labor.....hours..	2.7	2.7	2.7	1.9	2.1	2.0
Horse labor.....do....	.6	.5	.6	.4	.3	.4
Other costs:						
Building charges.....dollars..	0.177	0.174	0.176	0.128	0.140	0.133
Equipment charges and dairy supplies .....dollars..	.077	.097	.087	.056	.078	.066
Motor-truck charges.....do....	.....	.003	.002	.005	.017	.010

TABLE 1.—*Unit requirements, except charge for management, etc.*—Continued.

Item.	Winter.		Average of two winters.	Summer.		Average of two summers.
	1916–17	1917–18		1917	1918	
Other costs—Continued.						
Herd charges—						
Taxes, insurance, veterinary, medicine, disinfectants, and cow-testing associations.dollars..	.048	.066	.056	.035	.053	.043
Interest on cow investment.....do....	.098	.118	.107	.071	.095	.082
Cost of keeping bull.....do....	.033	.063	.048	.018	.046	.031
Total of other costs except appreciation and depreciation on cows.....dollars..	.433	.521	.476	.313	.429	.365
Depreciation on cows.....do....	.....	.166	.079	.....	.133	.060
Appreciation on cows.....do....	.....	.....	.....	.....	.....	.....
Total of other costs .....dollars..	.433	.687	**.555**	.313	.562	**.425**

NOTE.—The summaries of the unit requirements are printed in bold-faced type for convenient reference.

TABLE 2.—*Credit for calves and manure for each 100 pounds of milk produced.*

Item.	Winter.		Average of two winters.	Summer.		Average of two summers.
	1916–17	1917–18		1917	1918	
Credit for calves.....number..	0.024	0.026	0.025	0.009	0.009	0.009
Credit for manure.....pounds..	370	394	382	46	68	56

REQUIREMENTS FOR KEEPING A COW ONE YEAR.

The requirements for keeping a cow for one year are shown in Table 3. It will be noted that there was a wide variation between the quantities of purchased and home-grown concentrates fed. Most of the dry roughage fed consisted of salable hay. Of course, the difference between the quantities of feed used in winter and in summer was due to the large amount of pasture grazed during the summer.

TABLE 3.—*Number of cows, average production, and requirements for keeping a cow, except charge for management, based on the records obtained for the two years, 1916–17 and 1917–18.*

Item.	Winter.	Summer.	Entire year.
Number of cows.....average..	819.2	874.6	847.0
Average production.....pounds..	2,353	2,899	5,252
Feed:			
Purchased concentrates.....do....	696	235	931
Home-grown grains.....do....	83	16	99
Total concentrates.....do....	779	251	1,030
Noncommercial roughage.....do....	27	61	88
Commercial carbohydrate hay.....do....	2,700	403	3,103
Commercial legume hay.....do....	330	79	409
Total dry roughage.....do....	3,057	543	3,600

TABLE 3.—*Number of cows, average production, etc.*—Continued.

Item.	Winter.	Summer.	Entire year.
Feed—Continued.			
Silage and other succulent roughage.....pounds..	4,502	805	5,307
Pasture.....acres..	.....	3.0	3.0
Bedding[1].....pounds..	263	.....	263
Hauling and grinding concentrates.....dollars..	0.47	0.14	0.61
Labor:			
Human labor.....hours..	64.2	58.8	123.0
Horse labor.....do....	13.7	10.4	24.1
Other costs:			
Building charges.....dollars..	4.13	3.87	8.00
Equipment charges and dairy supplies.....do....	2.04	1.91	3.95
Motor truck charge.....do....	.04	.30	.34
Herd charges—			
Taxes, insurance, veterinary, medicine, disinfectants, and cow-testing association.....dollars..	1.33	1.24	2.57
Interest on cow investment.....do....	2.52	2.37	4.89
Cost of keeping bull.....do....	1.12	.89	2.01
Total of other costs, except depreciation and appreciation on cows.....dollars..	11.18	10.58	21.76
Depreciation on cows.....do....	1.86	1.74	3.60
Appreciation on cows.....do....	.....	.....	.....
Total other costs.....do....	13.04	12.32	25.36

[1] The small amount of bedding used was partly due to the use of refuse hay and other roughage left in the mangers.

The fact that almost as much labor was required to care for a cow in the summer as in the winter probably was due to the lower proportion of dry cows and a higher production in the summer, which made it necessary to use more labor for milking.

TABLE 4.—*Cost of keeping a cow and per cent increase of the cost for the second year over the first.*

Item.	1916–17	1917–18	Increase in cost of second year over first year.
			Per cent.
Feed, pasture, and bedding	$50.24	$65.74	30.9
Labor	20.73	23.47	13.2
Other costs except depreciation or appreciation on livestock	19.67	24.04	60.7
Appreciation on livestock	.....	.....	
Depreciation on livestock	.....	7.56	
Yearly cost per cow	90.64	120.81	33.3
Credit for calves and manure	22.32	26.68	19.5

An increase in the market price for cows increased the inventory so much at the end of the first year that it just balanced the depreciation on the herd. There was an increase in prices during the second year also, but the losses from tuberculosis in a number of the herds were large enough to overbalance the increase in market values and result in a net depreciation of $7.56 per cow.

CREDIT FOR CALVES AND MANURE.

CALVES.

Most of the heifer calves were raised or sold to neighbors for raising. The grade bull calves were usually vealed, and the whole milk sucked from the cows was credited to the herd by crediting the selling price of the calves and not the birth value.

TABLE 5.—*Credit for calves produced, by years and seasons.*

Item.	Year.		Seasons.	
	1916–17	1917–18	Two winters.	Two summers.
Number of calves	374	341	481	234
Total value of calves.....dollars..	2,275.05	2,647.37	3,160.99	1,761.43
Average value of calves.....do....	6.08	7.76	6.57	7.53
Calves per cow	0.84	0.85	0.58	0.27
Credit per cow.....dollars..	5.13	6.56	3.86	2.01

Since the purebred cows were given the same value as grade cows of like producing ability, the purebred bull calves were credited to the herds at what they would have been worth when 4 days old to fatten for veal and the purebred heifer calves at the value of grade heifer calves.

MANURE.

The credit for manure was figured after taking the following factors into consideration: Fertilizing constituents in the feeds;[3] quantities of nitrogen, phosphoric acid, and potash not utilized in the bodies of the cows but voided in the manure; the per cent of the total manure dropped in the barn; the per cent of manure saved in the storing and handling; the nitrogen, phosphoric acid, and potash contained in the bedding; and the value of these fertilizing constituents saved in the manure and bedding, all being figured at wholesale prices for commercial fertilizer.

TABLE 6.—*Credit for manure and fertilizing constituents, by seasons.*

Item.	Winter.	Summer.
Manure and bedding saved:	*Tons.*	*Tons.*
First year	1,862.7	327.9
Second year	1,815.4	384.4
Average per cow	4.5	0.8

[3] Obtained from "Feeds and Feeding," by Henry and Morrison.

TABLE 6.—*Credit for manure and fertilizing constituents by seasons*—Continued.

Item.	Winter.			Summer.		
	Nitrogen.	Phosphoric acid.	Potash.	Nitrogen.	Phosphoric acid.	Potash.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Manure	39,470	13,005	42,102	7,587	2,525	8,152
Bedding	1,145	397	2,854			
Total fertilizing constituents	40,615	13,402	44,956	7,587	2,525	8,152
Credit per cow	49.6	16.4	54.9	8.7	2.9	9.3

The average credit allowed for manure and bedding each year includes the manure from the bulls, and represents what was or could easily have been saved under local conditions. Since the total cost of keeping bulls is charged against the cows, the bull manure is included as a direct credit to the herd, and the combined credit was estimated to be 5.3 tons per cow.

The fertilizing constituents in 1 ton of average manure and bedding from the cows during the winter were estimated to be as follows:

	Pounds per ton.
Nitrogen	10.8
Commercial phosphoric acid	3.5
Potash	11.9

Without bedding, 1 ton of average winter manure was estimated to contain:

	Pounds per ton.
Nitrogen	10.7
Commercial phosphoric acid	3.5
Potash	11.4

The fertilizing constituents in the manure and bedding were valued at the following prices a pound during the first year: Nitrogen, 21 cents; commercial phosphoric acid, 6 cents; and potash, 7 cents; and during the second year: Nitrogen, 25 cents; phosphoric acid, 6 cents; and potash, 7 cents.

On the average dairy farm the commercial value of manure depends upon the use to which it is put. The return in dollars depends upon the increase in the crops raised and the amount received from the sale of these crops. These facts may reduce or increase the value of manure below or above the market price of the fertilizing constituents contained in it.

REQUIREMENTS FOR KEEPING A BULL.

The record on one bull for one month, called a bull month, was taken as a working unit. The bulls on about three-fourths of the farms were kept in the barn in the summer. This accounts for the

comparatively large amount of labor and feed required during the summer.

TABLE 7.—*Requirements for keeping a bull, based on averages obtained from the equivalent of 27.1 bulls.*

Item.	Average of two winters.	Average of two summers.	Average for year.
Feed:			
Purchased concentrates.....pounds..	162	104	266
Home-grown grains.....do....	57	13	70
Total concentrates.....do....	219	117	336
Dry roughage:			
Noncommercial.....do....	56	68	124
Commercial carbohydrate hay.....do....	2,894	2,717	5,611
Commercial legume hay.....do....	765	234	999
Total dry roughage.....do....	3,715	3,019	6,734
Silage and other succulent roughage.....do....	1,819	577	2,396
Bedding.....do....	269	.....	269
Pasture.....dollars..	.....	1.92	1.92
Human labor.....hours..	22.3	15.4	37.7
Other costs:			
Interest on bull investment.....dollars..	3.06	3.55	6.61
Bull's share of buildings.....do....	4.13	3.47	7.60
Total of other costs.....do....	7.19	7.02	14.21
Appreciation on bull.....do....	1.09	.99	2.08
Total of other costs less appreciation.....do....	6.10	6.03	12.13

The appreciation was due to the fact that in the first inventory the value of the bulls was placed at $125 a head. While in the herd they increased in size and thus increased their selling price when sold for beef.

FACTORS INVOLVED IN THE PRODUCTION OF MILK.

FEED.

The cost of hauling purchased concentrates varied from 50 cents to $1.50 a ton and the grinding charges ranged from 6 cents to 12 cents for each 100 pounds of grain. The quantities of the different kinds of feed were obtained from actual weights made by the cow tester during one full day of each month. The quantities were also checked frequently by the field agent.

Concentrates is a term applied to grains and to manufactured by-products suitable for feeding. The concentrates are low in fiber and contain a large amount of nutritive material in a relatively small bulk.

Home-grown grains consist of concentrates commonly grown on the farm or in the locality where fed.

Noncommercial dry roughage applies to corn stover, corn fodder, and other dry, coarse feeds for which price quotations are not given in the trade papers. The term is also applied to hay so foul with weeds or so damaged in curing as not to be readily salable.

Leguminous roughage includes alfalfa, clover, cowpea, soy bean, and other legume hays when pure, or when so slightly mixed with grasses as not materially to affect the protein content.

Commercial carbohydrate roughage includes all commercial hays except those classified as leguminous roughage.

PASTURE.

The pasture cost included the interest on the value of the land, the general cost of maintaining the fences, and such other items as seeding, cutting weeds, and repair and maintenance of watering troughs. The value of the land was obtained by subtracting the value of the improvements from the total value of the farm. The cost of pasture was distributed over the six summer months on a percentage basis. The per cent allowed for each month on each farm was estimated as nearly as possible in proportion to the condition of the pasture and the quantity of feed the herd received from the grass each month. The average from the various farms gave the following per cents of pasturage for the summer months: May, 15 per cent; June, 22 per cent; July, 18 per cent; August, 16 per cent; September, 15 per cent; October, 14 per cent.

LABOR.

The hours of labor were obtained by actually timing the various labor operations performed about the dairy during one entire day each month; this time was multiplied by the number of working days in that month plus the hours of work done on Sundays.

TABLE 8.—*Per cent of labor performed and hours per 100 pounds of milk for each class of help.*

	Distribution of work performed.			Labor per 100 pounds milk.		
	1916–17	1917–18	Average.	1916–17	1917–18	Average.
	Per cent.	*Per cent.*	*Per cent.*	*Hours.*	*Hours.*	*Hours.*
WINTER.						
Managers	41.7	41.7	41.7	1.1	1.1	1.1
Hired men	50.3	43.6	47.0	1.4	1.2	1.3
Total man labor	92.0	85.3	88.7	2.5	2.3	2.4
Women	3.2	3.8	3.5	.1	.1	.1
Boys and girls	4.8	10.9	7.8	.1	.3	.2
Total	100.0	100.0	100.0	2.7	2.7	2.7
SUMMER.						
Managers	40.2	37.9	39.1	0.8	0.8	0.8
Hired men	44.1	40.8	42.4	.8	.9	.8
Total man labor	84.3	78.7	81.5	1.6	1.7	1.6
Women	5.4	4.3	4.9	.1	.1	.1
Boys and girls	10.3	17.0	13.6	.2	.3	.3
Total	100.0	100.0	100.0	1.9	2.1	2.0

TABLE 9.—*Human labor required for producing, handling, and hauling 100 pounds of milk to the shipping platform.*

Kind of work.	Winter.				Average of 2 winters.		Summer.				Average of 2 summers.	
	1916-17		1917-18				1917		1918			
	Hours.	*Per cent.*	*Hours.*	*Per cent.*	*Hours.*	*Per cent.*	*Hours.*	*Per cent.*	*Hours.*	*Per cent.*	*Hours.*	*Per cent.*
Production.....	2.2	81.0	2.1	78.7	2.2	79.9	1.5	77.8	1.6	77.3	1.6	77.6
Handling.....	.2	6.8	.2	8.2	.2	7.4	.2	8.9	.2	10.0	.2	9.4
Hauling.....	.3	12.2	.4	13.1	.3	12.7	.2	13.3	.3	12.7	.2	13.0
Total.....	2.7	100.0	2.7	100.0	2.7	100.0	1.9	100.0	2.1	100.0	2.0	100.0

OTHER COSTS.

The "other costs" charged against the production of milk did not include the interest, taxes, and similar items against the entire farming enterprise, but covered only the dairy's share of the buildings and equipment.

BUILDINGS.

Interest was figured at the customary rate of 5 per cent on improved real estate on the inventory value taken at the beginning of the year. The annual depreciation charge was obtained by dividing the first inventory by the number of years it was estimated the buildings would remain in a usable condition. The annual cost of painting and repairs was computed. Slate roofs, because of their long life and durability, made the depreciation lower on many of the buildings. Taxes and insurance premiums were obtained by examining the individual tax records and insurance premium receipts. Annual repairs were included in the general charge against the buildings. The expense for buildings charged against the dairy was in proportion to the space used for it. The total amount of these charges amounted to 9.5 per cent of the inventory value of the portion of the buildings used by the herd.

EQUIPMENT.

An inventory was taken at the beginning and end of each year. Six per cent interest was charged on the first inventory value. The difference between the first inventory plus equipment purchased and the inventory taken at the end of the year plus equipment sold constituted the depreciation. A record of all repairs on equipment was kept by the dairyman and given to the field agent each month. The total of these charges amounted to 26.3 per cent of the inventory value of the equipment. Miscellaneous supplies, such as strainer cloths, washing powder, brushes, gasoline, and oil for running machines, amounted to 70 cents per cow per year.

HERD.

Each cow and bull was inventoried at the beginning of each year at the market value, and to this inventory was added the value of animals entering the herd during the year. Interest was figured at 6 per cent. Each grade cow purchased or sold was recorded at the price paid.

As the requirements for producing milk by a purebred cow are the same as by a grade cow of equal productive capacity, it becomes apparent that her greater value is due to the value of her offspring and not the value of her milk. Since the purpose of the bulletin is to deal with the requirements for producing milk, raising purebreds must be considered as a separate business. In order to avoid the influence of the purebred business upon the requirements for producing milk, purebred cows have been given the same value as grade cows of the same productive capacity and purebred calves have been given corresponding grade values.

Death losses were taken care of in the difference in inventories. At the end of the year the inventory value of each animal in the herd took into consideration any increase or decrease in value over the first inventory. To the second inventory was added the value of cows or hides sold during the year. The difference between these amounts constituted the depreciation or appreciation. During the first year there was no change in the value of the average cow, but during the second year the removal of animals with tuberculosis brought a heavy depreciation charge which probably had been accumulating during past years. Undoubtedly it was much larger than it would have been if the herds had been tested regularly for tuberculosis.

The taxes were obtained directly from the township records, and where insurance was carried the amount of the premiums was obtained from the receipts. The total of all costs against the herds amounted to 11.4 per cent of the inventory value taken at the beginning of each year.

Such miscellaneous items as veterinary services, medicines, disinfectants, and cow-testing-association dues were the sum total of money actually paid out as shown by the monthly records of the individual herds. These expenses amounted to $1.78 per cow per year.

The feed, labor, and other costs for keeping the herd sires were placed under herd charges and amounted to $2.01 per cow per year. The unit requirements for keeping a bull are given in Table 7, so that present prices can be used to approximate the present cost.

MOTOR-TRUCK CHARGES.

On some of the farms the milk was hauled by motor trucks during a part of the year, and the charge was based directly upon the cost of keeping and operating the truck.

TABLE 10.—*Per cent relationship between the other costs and the capital invested for all herds.*

Item.	Buildings.	Equipment.	Herds.	Total investment.
Capital invested	$71,028.50	$10,461.37	$69,048.00	$150,537.87
Capital invested, per cow	83.86	12.35	81 52	177.73
	Per cent.	*Per cent.*	*Per cent.*	
Interest	4.8	6.0	6.0	
Depreciation	2.6	17.8	4.4	
Taxes	.9		1.0	
Insurance	.3			
Upkeep and repairs	.9	.8		
Milking-machine repairs		1.7		
Total of other costs	9.5	26.3	11.4	11.5

The figures at the foot of each of the four columns show the per cent relationship of the cost to the capital invested as recorded at the heads of the columns.

PER CENT COMPARISONS OF FACTORS INVOLVED IN COST OF MILK PRODUCTION.

There was a noticeable difference in the cost of producing milk in winter and in summer. The following table shows that the cost of the feed was the chief cause of this difference.

TABLE 11.—*Per cent of the 2-year cost of milk production represented by feed, labor, and overhead and other costs.*

Cost item.	Average of 2 winters.	Average of 2 summers.	Average of 2 years.
	Per cent.	*Per cent.*	*Per cent.*
Feed and bedding	39.0	10.4	49.4
Pasture		5.5	5.5
Labor	10.8	10.2	21.0
Other costs except herd inventory variations	10.3	10.4	20.7
Total cost except herd inventory variations	60.1	36.5	96.6
Herd depreciation	1.7	1.7	3.4
Total cost of production	61.8	38.2	100.0
Credits:			
Calves	3.5	2.0	5.5
Manure	14.9	2.8	17.7
Total for calves and manure	18.4	4.8	23.2

The cost of feed, bedding, and pasture in winter was 39 per cent of the yearly cost, while in summer it amounted to 15.9 per cent of the yearly cost. It is also interesting to note that the labor cost and other costs except the herd inventory variations were practically the same in winter and in summer, and also equal to each other, being slightly more than 10 per cent in each season for each of the two items. The average yearly cost is shown in the last column.

The percentages obtained show the relationship which existed between the various factors under the system of dairy management

practiced in this section where many cows freshened in the spring and where a large amount of good pasture furnished an abundance of feed for "summer dairying." Although they may approximate the relationship found in near-by sections, they can not be applied to all sections of the United States.

DETERMINATION OF THE BULK LINE OF PRODUCTION.

When it is required to fix a price to represent the cost of producing milk for any section or group of dairymen, it is evident that if the actual average cost is used for this purpose then one-half of the milk is produced at a cost greater than the sum fixed. Therefore, if the price of milk is based on the average cost of production it would tend to discourage production and decrease the supply. On the other hand, the least economical producers should have little influence in determining the cost of production for any group of dairymen.

There is a line on the scale of costs, however, below which the greater quantity of the milk is produced. This line, called the bulk line, is placed where it will usually include from 80 to 90 per cent of the volume of milk produced. It is aimed to cover the cost of producing all milk except that produced at extremely high costs.

Some of the factors to take into consideration in locating the bulk line are illustrated in figures 1 and 2. Attention is called to the fact that the higher the cost the less the volume of milk produced. The horizontal lines which indicate volume of milk are long in the middle of the group and the vertical lines are short, but as the cost of production increases the vertical lines rapidly increase in length.

As regards the placing of the bulk line in connection with the volume of milk produced in the present investigation, the line for the summer of 1917 might have been located in figure 1 at the point A, or possibly at C, but hardly at E, because the rapid increase in cost, as shown by the length of the line CD, is not compensated for by the extra volume of milk (line DE) produced at the high cost. Similarly the line for the summer of 1918 would not be placed higher than F. The bulk line for the winter production of 1916–17 (fig. 2) might be placed at either A or B, and that for the winter of 1917–18 at C.

MONTHLY DISTRIBUTION OF FACTORS IN MILK PRODUCTION.

The lower net feed cost for November as compared with October in Table 14 is due to the larger credit for the amount of manure voided in the barn. The gross feed and bedding cost is a more accurate index of the relationship of the cost of feed in October and November.

It will be noted that during the first year the income from milk during each season corresponded very closely to the volume of milk

produced. In each year, however, there was no correlation between the seasonal production of milk and the gross cost of feed required

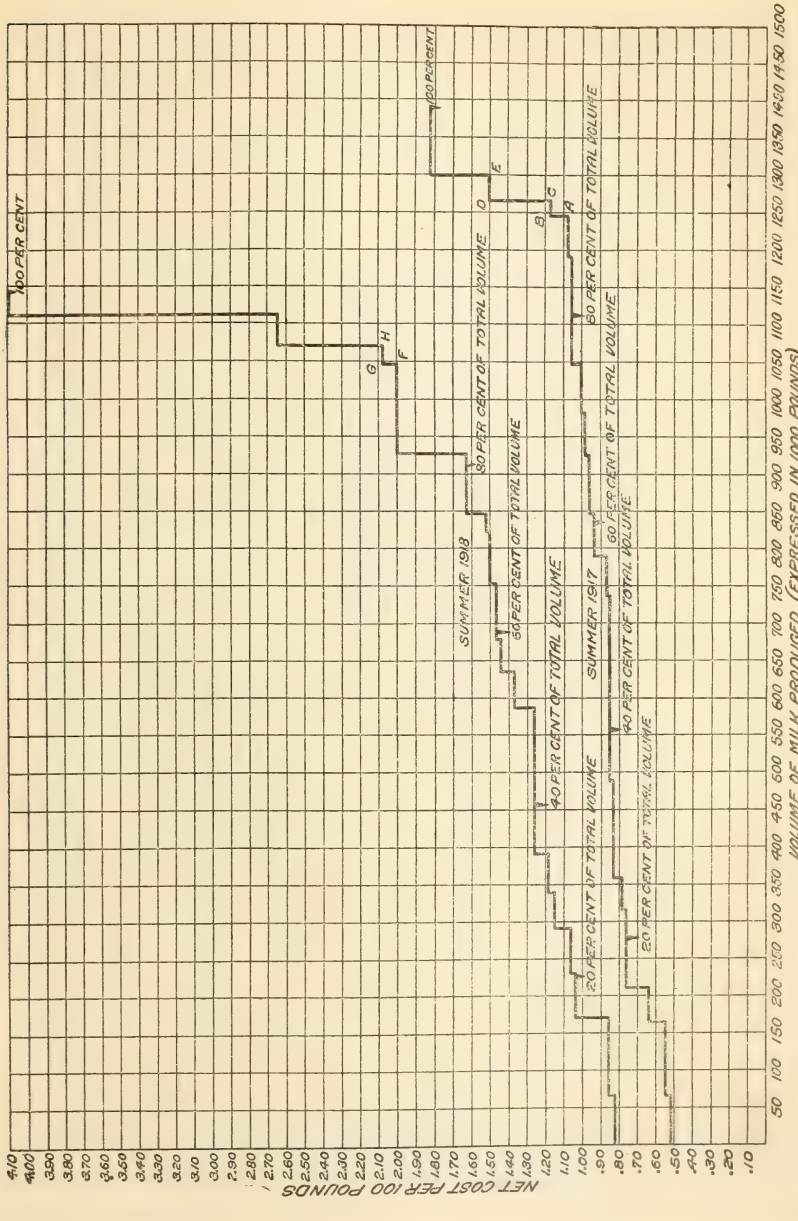

Fig. 1.—Volume of milk produced and the net cost in summer.

to produce it. There was no correlation between the feed cost and the income from milk, although the per cent of income from milk during the second season more nearly corresponds to that of the

gross feed cost of producing it than during the first winter. This was due to a higher price paid for milk during the second winter.

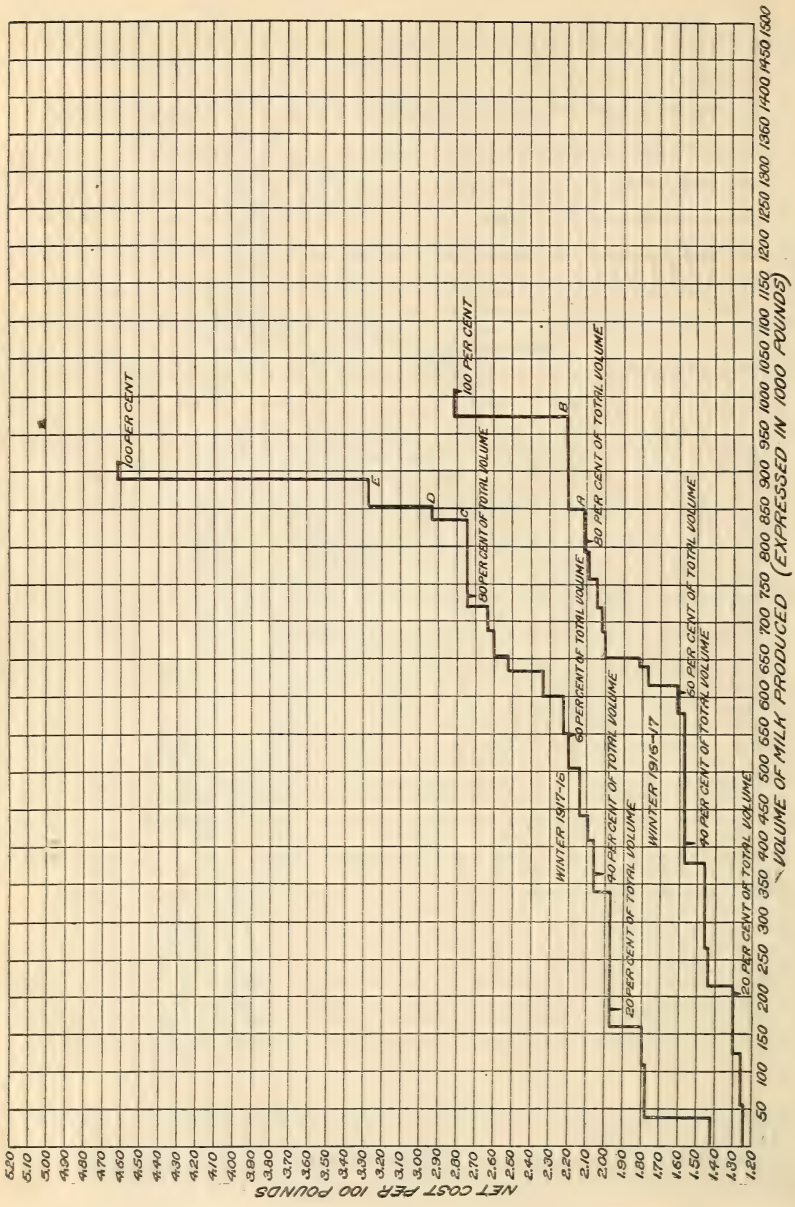

FIG. 2.—Volume of milk produced and the net cost in winter.

It will be noted that the gross winter feed and bedding cost was 71.9 per cent and 72.4 per cent, respectively, of the first and second year's gross feed, pasture, and bedding cost, while the per cent of the

year's milk production for the same season was 42 and 44.5, respectively. Subtracting the credit for manure and bedding from the cost of feed, pasture, and bedding in winter produced a closer correlation to the price received for winter milk. However, this did not prove to be equally true for the summer season.

TABLE 12.—*Distribution, by months, of milk prices, milk sold and used, feed cost, and labor required for two years.*

Months and seasons.	Price received per 100 pounds of milk.	Year's income from milk sold and used.	Year's milk sold and used.	Year's feed, pasture, and bedding cost.	Feed, pasture, and bedding cost minus manure and bedding credit.	Human labor.		Horse labor.	
						Per 100 pounds milk.	Per cow.	Per 100 pounds milk.	Per cow.
1916-17.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
May	$2.20	10.1	11.5	10.3	9.5	1.8	10.9	0.3	1.8
June	2.11	11.0	13.2	2.4	1.6	1.5	10.5	3	2.0
July	2.30	10.5	11.4	2.2	1.3	1.8	10.9	.3	1.9
August	2.79	9.4	8.5	2.8	1.9	2.2	9.7	.4	1.7
September	2.83	8.3	7.4	3.8	2.9	2.2	8.6	.5	1.8
October	3.40	8.1	6.0	6.6	5.8	2.5	8.0	.6	1.9
Summer	2.49	57.4	58.0	28.1	23.0	1.9	9.8	.4	1.9
November	3.08	6.7	5.5	9.7	4.9	2.9	8.6	.6	1.9
December	2.74	6.4	5.9	11.8	7.0	3.0	10.0	.5	1.7
January	2.61	6.2	5.9	10.9	6.0	3.4	11.8	1.0	3.4
February	2.52	6.4	6.4	12.2	7.4	2.7	9.7	.7	2.6
March	2.38	8.0	8.4	13.4	8.5	2.4	11.1	.6	2.6
April	2.26	8.9	9.9	13.9	9.0	2.3	12.2	.5	2.4
Winter	2.55	42.6	42.0	71.9	42.8	2.7	10.6	.6	2.4
Entire year		100.0	100.0	100.0	65.8				
1917-18.									
May	2.62	11.2	12.8	4.6	3.7	1.8	11.2	.3	1.9
June	1.96	8.4	12.7	3.3	2.4	1.7	10.7	.3	1.7
July	2.40	8.5	10.6	3.0	2.1	2.0	10.3	.4	1.9
August	2.91	7.6	7.8	2.9	2.0	2.4	9.2	.4	1.4
September	3.19	6.7	6.3	5.0	4.1	2.7	8.4	.4	1.2
October	3.86	6.9	5.3	8.8	7.9	3.4	9.0	.5	1.2
Summer	2.65	49.3	55.5	27.6	22.2	2.1	9.8	.3	1.6
November	3.93	6.9	5.2	10.9	6.6	3.3	8.4	.6	1.5
December	3.84	8.3	6.4	11.9	7.5	3.1	10.4	.6	2.1
January	3.55	8.4	7.1	11.7	7.3	3.1	11.8	.8	2.9
February	3.38	7.8	6.8	11.3	6.9	2.6	10.2	.4	1.6
March	3.43	9.9	8.6	12.3	8.0	2.5	12.2	.4	2.1
April	2.70	9.4	10.4	14.3	9.9	2.2	12.1	.4	2.3
Winter	3.39	50.7	44.5	72.4	46.2	2.7	10.8	.5	2.1
Entire year		100.0	100.0	100.0	68.4				

SUMMARY.

The figures reported in this study were obtained from typical farms in a market milk section of Vermont. Although they show the requirements for producing milk in that section and may approximate the requirements in similar sections, they do not apply to dairy sections where other conditions and methods of management prevail.

The unit requirements for producing 100 pounds of milk in winter were: Concentrates, 33.1 pounds; hauling and grinding concentrates, 2 cents; dry roughage, 129.9 pounds; silage and other succulent roughage, 191.3 pounds; bedding, 11.2 pounds; human labor, 2.7 hours; horse labor, 0.6 hour; other costs, 55.5 cents. The credits other than milk were 0.025 of one calf and 382 pounds of manure. (Tables 1 and 2.)

In summer the unit requirements were: Concentrates, 8.7 pounds; hauling and grinding concentrates, 0.5 cent; dry roughage, 18.7 pounds; silage and other succulent roughage, 27.8 pounds; pasture, 0.1 acre; human labor, 2 hours; horse labor, 0.4 hour; other costs, 42.5 cents. The credits other than milk were 0.009 of one calf and 56 pounds of manure.

The unit requirements for keeping a cow one year were as follows: Concentrates, 1,030 pounds; hauling and grinding concentrates, 61 cents; dry roughage, 3,600 pounds; silage and other succulent roughage, 5,307 pounds; bedding, 263 pounds; pasture, 3 acres; human labor, 123 hours; horse labor, 24.1 hours; other costs, $25.36 without charge for management. Credits other than milk; 0.85 of one calf; 5.3 tons manure. (Table 3.)

The tabulation of the figures obtained for the expenses of the herd and for the herd's share of the buildings and equipment showed that the annual expense for the buildings amounted to 9.5 per cent of the inventory value of the buildings. The charges on equipment were 26.3 per cent of the inventory value of the equipment; and the herd charges amounted to 11.4 per cent of the inventory value of the herd. The total of the charges against buildings, equipment, and livestock amounted to 11.5 per cent of the capital invested in them.

The percentages of the total cost represented by the various cost and credit factors, except charge for management, were as follows: Feed, pasture, and bedding, 54.9 per cent; labor, 21 per cent; other costs, 24.1 per cent; credit for calves and manure, 23.2 per cent of the cost. (Table 11.)

The men performed 88.7 per cent and 81.5 per cent of the work in the winter and summer periods, respectively. The remainder of the work was done by women or by boys and girls. (Table 8.)

In the winter periods the dairymen received much less for their milk than the gross feed and bedding costs of producing it; there was a reversal of this situation during the summer. (Table 12.)

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